

CLAIMS

What is claimed is:

1. An apparatus for inspecting a substrate using charged particles, the apparatus
5 comprising:
an illumination subsystem configured to generate an incident charged-particle
beam;
an objective subsystem configured to receive the incident beam, to focus the
incident beam onto the substrate, and to retrieve a scattered beam from
10 the substrate;
a projection subsystem configured to receive the scattered beam and to project
the scattered beam onto a detector; and
a beam separator coupled to and interconnecting the illumination subsystem,
the objective subsystem, and the projection subsystem,
15 wherein the beam separator is configured to receive the incident beam from
the illumination subsystem, bend the incident beam towards the objective
subsystem, receive the scattered beam from the objective subsystem,
and bend the scattered beam towards the projection subsystem, and
wherein the beam separator comprises a magnetic prism array including a
20 central magnetic sector, inner magnetic sectors positioned outside the
central sector, and outer magnetic sectors positioned outside the inner
magnetic sectors.
2. The apparatus of claim 1, wherein the central sector generates a first magnetic
25 field of a first field strength, each inner sector generates a second magnetic
field of a second field strength, and each outer sector generates a third
magnetic field of a third field strength.
3. The apparatus of claim 2, wherein the first magnetic field causes beam
30 deflection of a first angle, the second magnetic field causes beam deflection of

a second angle, and the third magnetic field causes beam deflection of a third angle.

4. The apparatus of claim 3, wherein the first angle, twice the second angle, and
5 twice the third angle sum to a bending angle of approximately ninety degrees.
5. The apparatus of claim 4, wherein each of the inner and outer sectors is
configured to have its field strength independently adjustable.
- 10 6. The apparatus of claim 5, wherein the apparatus comprises a low-energy
electron microscope, wherein the incident beam comprises incident electrons,
and wherein the scattered beam comprises reflected electrons.
7. The apparatus of claim 1, wherein the inner sectors are configured with straight
15 edges and right angles.
8. The apparatus of claim 1, wherein the outer sectors are configured with straight
edges and right angles.
- 20 9. The apparatus of claim 1, wherein the magnetic prism array is configured such
that the incident beam passes through a first outer sector, a first inner sector,
the central section, a second inner sector, and a second outer sector.
10. The apparatus of claim 9, wherein the magnetic prism array is further
25 configured such that the scattered beam passes through the second outer
sector, the second inner sector, the central section, a third inner sector, and a
third outer sector.
11. A beam separator for use in an electron beam inspection apparatus, the beam
30 separator comprising:
a central magnetic sector;

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inner magnetic sectors outside the central magnetic sector; and
outer magnetic sectors outside the inner magnetic sectors,
wherein the central magnetic sector generates a first magnetic field of a first
field strength, each inner magnetic sector generates a second magnetic
5 field of a second field strength, and each outer magnetic sector generates
a third magnetic field of a third field strength.

12. The beam separator of claim 11, wherein the first magnetic field causes beam
deflection of a first angle, the second magnetic field causes beam deflection of
10 a second angle, and the third magnetic field causes beam deflection of a third
angle, and wherein the first angle, twice the second angle, and twice the third
angle sum to a bending angle of approximately ninety degrees.

13. The beam separator of claim 12, wherein each of the inner and outer sectors is
15 configured to have its field strength adjusted independently.

14. A method of inspecting a substrate using charged particles, the method
comprising:
generating an incident charged-particle beam;
20 bending the incident beam through a first outer magnetic sector, a first inner
magnetic sector, a central magnetic sector, a second inner magnetic
sector, and a second outer magnetic sector;
focusing the incident beam to a substrate;
retrieving a reflected charged-particle beam;
25 bending the reflected beam through the second outer magnetic sector, the
second inner magnetic sector, the central magnetic sector, a third inner
magnetic sector, and a third outer magnetic sector;
projecting the reflected beam to a detection system.

15. The method of claim 14, wherein the incident beam is bent through an angle of
30 approximately ninety degrees.

16. The method of claim 15, wherein the reflected beam is bent through an angle of approximately ninety degrees.

5 17. The method of claim 16, wherein field strengths of the magnetic sectors are independently adjustable.

10 18. The method of claim 17, wherein varying magnetic field strengths of the inner magnetic sectors varies an effective length of the central and outer magnetic sectors.

19. The method of claim 18, wherein the charged particles comprise electrons.

15 20. A low-energy electron beam inspection apparatus, the apparatus comprising:
means for generating an incident charged-particle beam;
means for decelerating and focusing the incident beam to a substrate;
means for accelerating and refocusing a reflected charged-particle beam;
means for projecting the reflected beam to a detection system to form a two-dimensional image; and
20 a magnetic prism array configured to bend the incident beam through a first outer magnetic sector, a first inner magnetic sector, a central magnetic sector, a second inner magnetic sector, and a second outer magnetic sector, and further configured to bend the reflected beam through the second outer magnetic sector, the second inner magnetic sector, the
25 central magnetic sector, a third inner magnetic sector, and a third outer magnetic sector.